

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE  
NUMBER: M0-AD1-M16 -X**

**SUBSYSTEM NAME:** REMOTELY OPERATED ELECTRICAL UMBILICAL

**REVISION:** 1 02/11/91

**PART DATA**

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	<b>PART NAME</b>	<b>PART NUMBER</b>
	<b>VENDOR NAME</b>	<b>VENDOR NUMBER</b>
SRU	: MECHANICAL LINKAGE COMPONENTS	V751-544112
SRU	: MECHANICAL LINKAGE COMPONENTS	V751-544113
SRU	: MECHANICAL LINKAGE COMPONENTS	V751-544114
SRU	: MECHANICAL LINKAGE COMPONENTS	V751-544116
SRU	: MECHANICAL LINKAGE COMPONENTS	V751-544117
SRU	: MECHANICAL LINKAGE COMPONENTS	V751-544118
SRU	: MECHANICAL LINKAGE COMPONENTS	V751-544180
SRU	: MECHANICAL LINKAGE COMPONENTS	V751-544253

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**EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:**

**REFERENCE DESIGNATORS:**

**QUANTITY OF LIKE ITEMS:**  
ONE PER ROEU ASSEMBLY

**FUNCTION:**  
THIS ASSEMBLY OF MECHANICAL COMPONENTS TRANSFERS THE ROTATIONAL OUTPUT OF THE DUAL ELECTRIC MOTOR (SWING ARM) ACTUATOR INTO APPROPRIATE LINEAR MOTION TO MOVE THE ARM BETWEEN ITS MATE, STOW, AND RELAX POSITIONS.

**FAILURE MODES EFFECTS ANALYSIS FMEA -- CIL FAILURE MODE**

**NUMBER: M0-AD1-M16- 01**

**REVISION#: 2 01/07/02**

**SUBSYSTEM NAME: REMOTELY OPERATED ELECTRICAL UMBILICAL**

**LRU:**

**CRITICALITY OF THIS**

**ITEM NAME: MECHANICAL LINKAGE COMPONENTS**

**FAILURE MODE: 2/2**

**FAILURE MODE:**

PHYSICAL BINDING/JAMMING, FAILS FREE

**MISSION PHASE:**

OO ON-ORBIT

**VEHICLE/PAYLOAD/KIT EFFECTIVITY:**

- 102 COLUMBIA
- 103 DISCOVERY
- 104 ATLANTIS
- 105 ENDEAVOUR

**CAUSE:**

ADVERSE TOLERANCES/WEAR, CONTAMINATION/FOREIGN OBJECT/DEBRIS, LOSS OF LUBRICANT, FAILURE/DEFLECTION OF INTERNAL PART, TEMPERATURE, FATIGUE, VIBRATION

**CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO**

**REDUNDANCY SCREEN**

- A) N/A
- B) N/A
- C) N/A

**PASS/FAIL RATIONALE:**

- A)  
N/A
- B)  
N/A
- C)  
N/A

**- FAILURE EFFECTS -**

**(A) SUBSYSTEM:**

LOSS OF SWING ARM MATE/STOW/RELAX FUNCTIONS.

**(B) INTERFACING SUBSYSTEM(S):**

ORBITER-TO-PAYLOAD CONNECTOR CANNOT BE POSITIONED AS REQUIRED.

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**(C) MISSION:**

LOSS OF ROEU MISSION.

**(D) CREW, VEHICLE, AND ELEMENT(S):**

NO EFFECT.

**(E) FUNCTIONAL CRITICALITY EFFECTS:**

THESE FAILURE EFFECTS RESULT IN LOSS OF ARM MATE/STOW/RELAX CAPACITY.

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**-DISPOSITION RATIONALE-**

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**(A) DESIGN:**

DESIGN FACTOR OF SAFETY IS 1.4 X LIMIT LOAD. ALL COMPONENTS SHOW POSITIVE MARGINS BY ANALYSIS. DESIGN PRECLUDES DAMAGE UNDER STALLED CONDITION. EMERGENCY EVA DISCONNECT IS PROVIDED TO MANUALLY OVERRIDE INOPERATIVE LINKAGE AND MOVE THE ARM AS REQUIRED.

ALL THE MECHANISM MATERIALS HAVE BEEN CHOSEN FOR HIGH STRENGTH/LOW WEAR CHARACTERISTICS. MECHANISM DESIGNED WITH POSITIVE MARGINS OF SAFETY FOR WORSE CASE THERMAL CONDITIONS. ALIGNMENT MECHANISM DESIGNED TO ENSURE PROPER CAPTURE ENVELOPE FOR WORSE CASE THERMAL CONDITIONS. DESIGN OF THE SWING ARM SYSTEM PERMITS PARTIAL WORKAROUND BY CREW EVA ACTIONS.

**(B) TEST:**

QUALIFICATION: THE ROEU MECHANISM IS CERTIFIED PER CR 60-544100-001-C. SYSTEM QUALIFICATION TESTS INCLUDED:

- \* VISUAL EXAMINATION TO VERIFY CONFORMANCE TO DRAWINGS, IDENTIFICATION MARKINGS, AND CLEANLINESS.
- \* ENVIRONMENTAL TESTS - VIBRATION (BOOST) FOR 60 SEC/AXIS. FLIGHT VIBRATION FOR 140 SEC/AXIS. FIVE THERMAL/VACUUM CYCLES WITH SIMULATED ROEU/PAYLOAD DISPLACEMENTS.
- \* OPERATIONAL LIFE TESTS - 84 CYCLES ON ARM AND LATCH MECHANISM.
- \* QUALIFICATION ACCEPTANCE TESTS TO CERTIFY MECHANISM FOR FIVE ACCEPTANCE THERMAL AND FIVE ACCEPTANCE VIBRATION TESTS.
- \* MAXIMUM DISPLACEMENT TESTS TO VERIFY OPERATIONAL ENVELOPE.
- \* LIMIT, LIMIT PLUS LOADS TESTS TO VERIFY STATIC LOADING.
- \* ARM AND LATCH STALL LOAD TESTS.

ACCEPTANCE:

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THE ARM AND LATCH MECHANISMS WERE RIGGED PER CONTROLLED SPECIFICATION ML0308-0185, PLUS:

- \* ACCEPTANCE VIBRATION RANDOM SPECTRUM 3 MIN/AXIS.
- \* ACCEPTANCE THERMAL ONE AND ONE-HALF THERMAL CYCLES.

CERTIFICATION BY ANALYSIS/SIMILARITY:

FACTORS INCLUDE: HUMIDITY, FUNGUS, OZONE, SALTSpray, SAND/DUST, ACCELERATION, FACTORS OF SAFETY, HAIL, LIGHTNING, RAIN, SOLAR RADIATION (THERMAL AND NUCLEAR), STORAGE/OPERATING LIFE, METEOROIDS, ACOUSTICS, AND EXPLOSIVE ATMOSPHERE.

GROUND TURNAROUND:

OMRSD - ANY TURNAROUND TEST CHECKOUT TESTING IS ACCOMPLISHED IN ACCORDING WITH OMRSD

**(C) INSPECTION:**

RECEIVING INSPECTION  
MATERIAL AND PROCESS CERTIFICATIONS VERIFIED BY INSPECTION.

CONTAMINATION CONTROL  
INSPECTION VERIFIES CLEANLINESS IS MAINTAINED. INSPECTION VERIFIES CORROSION PROTECTION PER MA0608-301.

ASSEMBLY/INSTALLATION  
DIMENSIONS OF DETAIL PARTS VERIFIED BY INSPECTION. FASTENER INSTALLATION IS VERIFIED BY INSPECTION. ASSEMBLY AND RIGGING OF SWING ARM LINKAGE COMPONENTS IS VERIFIED BY INSPECTION.

NONDESTRUCTIVE EVALUATION  
PENETRANT INSPECTION OF DETAIL PARTS IS VERIFIED BY INSPECTION.

CRITICAL PROCESSES  
APPLICATION OF LB0140-005 DRY FILM LUBRICANT PER MA0112-302 IS VERIFIED BY INSPECTION. HEAT TREATING IS VERIFIED BY INSPECTION.

TESTING  
ACCEPTANCE TESTING OF THE SWING ARM LINKAGE COMPONENTS ASSEMBLY PRIOR TO DELIVERY IS VERIFIED BY INSPECTION PER APPLICABLE PROCEDURE.

HANDLING/PACKAGING  
HANDLING AND PACKAGING REQUIREMENTS ARE VERIFIED BY INSPECTION.

**(D) FAILURE HISTORY:**

CURRENT DATA ON TEST FAILURES, FLIGHT FAILURE, UNEXPLAINED ANOMALIES, AND OTHER FAILURE EXPERIENCED DURING GROUND PROCESSING ACTIVITY CAN BE FOUND IN THE PRACA DATA BASE.

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**(E) OPERATIONAL USE:**  
NONE

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**- APPROVALS -**

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S&R ENGINEER.	:A. NGUYEN	:/s/A. Nguyen_____
CARGO/INTEG ITM.	:J. CAPALENI	:/s/J. Capaleni_____
DESIGN ENGINEERING	:D. HAEHLKE	:/s/D. Haehlke_____
SSM	:P. REESE	:/s/P. Reese_____
MOD	:K. SMITH	:/s/K. Smith_____
USA/SAM	:R. SMITH	:/s/S.R. Smith_____
USA CARGO/INTG ELEMENT	:H. MALTBY	:/s/H. Maltby_____
USA ORBITER ELEMENT	:S. LITTLE	:/s/S. Little_____